

# THE HISTORY OF IMPLANT DENTISTRY

## Implant Dentistry

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## HISTORY OF DENTAL DISEASE

The records of ancient civilizations indicate that dental disease and tooth loss have afflicted humankind for thousands of years. The Ebers Papyri is the most voluminous and best preserved of the Egyptian medical papyri. It is a compilation of Egyptian manuscripts (some of which were written as early as 3700 B.C.). It makes multiple references to dental maladies and discusses treatments for “bennet blisters” and teeth that “gnaw into the upper part of the flesh.”<sup>1,2</sup> Radiographs made of Egyptian Pharoahs show periodontal disease and substantial tooth loss.<sup>3</sup> A mandible from about 2500 years ago, discovered in Lebanon, shows periodontally involved mandibular anterior teeth splinted together with gold wire (figures 1A, 1B).

## HISTORICAL IMPORTANCE OF TEETH

The importance of teeth has been documented by many civilizations. Sound, healthy teeth were highly valued by the early Hebrews.<sup>3</sup> Both the value and beauty of teeth were identified in the Old Testament book, Song of Solomon (Chapter 4, Verse 2), “Your teeth are white as sheep’s wool, newly shorn and washed, perfectly matched, without one missing.” These words express the esthetic concepts of color, evenness, alignment, bilateral symmetry, and completeness. They also convey the value and appreciation placed upon teeth.

## METHODS OF REPLACING MISSING TEETH

As a result of disease related tooth loss and the value placed upon teeth, there has been a continual search for methods by which missing teeth could be replaced.

Early artificial replacements were made from natural teeth and a variety of substitute materials. The replacements were attached to adjacent teeth using thread, wire, and metal bands.

The Phoenicians, early inhabitants of modern day Lebanon, were contemporaries of the Egyptians and Hebrews. They attached “ivory teeth” to adjacent natural teeth using gold wire.<sup>3</sup>

The Etruscans, from the central hills of Italy, were influenced by the Egyptian and Phoenician civilizations. They made gold bands to surround natural teeth between 1000 and 200 B.C.<sup>1</sup> to which they attached replacement teeth that were carved from calves teeth or the teeth of oxen. The “pontics” were riveted to the gold band.<sup>2</sup>

### **Replantation/Transplantation**

The Arabian surgeon, Albucasis (936-1013), is the first person to provide a written description of the replantation process that preceded the concept of transplantation.<sup>2</sup>

Allotransplantation of a tooth from one person to another was an early method by which lost teeth were replaced. Archeological discoveries indicate that many ancient civilizations practiced allogenic tooth transplantation. In 1561, Ambrose Pare (1517-1592) reported that decayed teeth could be replaced by using extracted teeth from another individual and is credited with being the first to mention transplantation.<sup>2</sup>

Tooth transplantation became a means by which the wealthy acquired teeth from the poor.<sup>4</sup> English newspapers frequently published advertisements that offered 2-3 pounds for each perfect central and lateral incisor.<sup>5</sup> The following advertisement appeared in New York papers in 1772: “Teeth – any person willing to dispose of his front teeth may hear of a purchaser by applying to number 28 Maiden Lane for which a generous price will be given. N.B. four guineas will be paid for every tooth.”<sup>5</sup>

Pierre Fauchard (1678-1768), in his epic work “The Surgeon-Dentist; or, Treatise on the Teeth,” discussed transplantation of teeth from one person to another.<sup>3</sup> An Englishman, John Hunter, was a strong proponent of tooth transplantation. He described the regeneration of blood vessels in a tooth’s pulp and periodontal ligament when the transplant tooth was placed into a cock’s comb. Teeth were preserved in the cock’s comb in the absence of refrigeration and other methods of preservation. Hunter introduced a technique where the teeth were extracted, boiled, and replanted.<sup>4</sup>

In the 1950’s, autotransplantation began to appear in the dental literature.<sup>6-8</sup> After the extraction of a nonrestorable first molar, an impacted developing third molar was transplanted into the position of the first molar.<sup>6,7</sup> A success rate of about 50% was experienced at that time and the process disappeared.<sup>9</sup> Recently, autotransplantation has resurfaced as a treatment modality with an increased success rate.<sup>4</sup>

### **Dental Implants**

Evidence of tooth replacement in the Americas was found in 1931 while Dr. and Mrs. Wilson Popenoe, an archeological team, were excavating in Honduras. They discovered a mandible of Mayan origin from about 600 AD that had tooth-shaped pieces of shells

placed into the sockets of three missing mandibular incisors.<sup>3</sup> The tooth-shaped shell implants and the jaw were examined radiographically and it was determined that compact bone had formed around 2 of the implants and the bone was radiographically similar to that which forms around blade implants. This may be the earliest example of any endosseous implant.<sup>10,11</sup>

## DEFINITION OF A DENTAL IMPLANT

The Glossary of Prosthodontic Terms<sup>12</sup> defines an implant as “a prosthetic device or alloplastic material implanted into the oral tissues beneath the mucosal or/and periosteal layer, and/or within the bone to provide retention and support for a fixed or removable prosthesis.”

## TYPES OF DENTAL IMPLANTS

Several types of implants have been used throughout history. They include **endosteal** implants that are placed into the bone (**2A**, **2B**, **2C**, **2D**), **eposteal** implants that are placed on or upon the bone (**3A**, **3B**, **3C**), and **transosteal** implants that are placed through the bone (**4A**, **4B**).<sup>12</sup>

**Endosteal** (endosseous) implants include those that approximate the shape and dimensions of tooth roots (also frequently called **root form implants**), those that are plates of metal (called **blade implants**), and those that are metal frameworks where only a portion of the metal is implanted into bone (ramus frame implants). It has been proposed that the term “root-form implant” be avoided since it perpetuates a faulty concept that cylindrical implants resemble the roots of natural teeth.<sup>13</sup> However, an alternate term that differentiates the endosseous implants that attempt to approximate the form of a tooth from those that are platelike in form has not emerged. Therefore, the term “endosseous root form implant” continues to be widely used.

**Eposteal** implants are commonly called **subperiosteal** implants because they are made to fit over the surface of the bone, beneath the periosteum and overlying mucosa.

**Transosteal** implants pass through the jaw and have been known by the terms **staple implant**<sup>14</sup> and **transmandibular implant**.<sup>15</sup>

## ENDOSTEAL DENTAL IMPLANT HISTORY

### Endosseous Root Form Implants

A variety of materials have been used in the past, including vulcanized rubber, porcelain, and several types of metals. Maggiolo of Paris used a gold implant in 1809 which is probably the earliest reference to an implant in the modern literature.<sup>10, 16-18</sup> Harris, from California, implanted a porcelain crown attached to a porcelain post into an artificially

created socket in 1886. Lead had been melted around the post and roughened for retention.<sup>10</sup>

In 1889, Edmunds of New York used a similar technique whereby a capsule of platinum foil was covered with lead, soldered with silver, and placed as an implant.<sup>10</sup>

Greenfield of Wichita, Kansas, patented a hollow lattice tapered cylindrical metal implant in 1909 (**figure 5**). He presented a clinic and exhibited a man wearing a maxillary complete denture supported by implants at the 1912 meeting of the National Dental Association.<sup>1</sup> Greenfield published a paper in 1913 where he described the hollow lattice implant that was fabricated from 24-gauge iridio-platinum wire soldered together with 24-carat gold.

In 1920, Ledger-Dorez<sup>16</sup> placed expandable implants comparable to expansion bolts (**figure 6**). Tompkins, in 1921, placed porcelain implants.<sup>16</sup> Rubber pins were implanted into surgically created sockets by Brill in 1936.<sup>16</sup>

Alvin Strock placed what may have been the first modestly successful root form implants in 1938 at Harvard University. Strock published a paper in 1939 that reviewed the early history of implants and possible reasons for their failure. He discussed the metal Vitallium (consisting of cobalt, chromium, and molybdenum) which was known to be better tolerated by the body than other metals. He reported on two animals and three humans where Vitallium screws had been implanted. In one of the patients, the tooth was extracted and the implant immediately placed and loaded. In another patient, the implant was placed about 3 weeks after tooth extraction. In the third patient, implants were placed into bone that had healed from previous extractions. Strock reported that one of his early implants was still intact after 15 years.<sup>21</sup>

In 1947, Formiggini of Italy developed an implant made of 2 pieces of tantalum wire twisted to form a spiral helix.<sup>16,18,22</sup> A variation of this implant form can be seen in **figure 7**. In 1959, Hodosh developed poly (methyl methacrylate) replicas of extracted teeth that were implanted in animals and humans.<sup>23-27</sup> In the early 1960's, Chercheve was using implants made of a chrome-cobalt alloy with a double spiral form (**figure 8**).<sup>16,18,28</sup>

In the 1950's and 1960's, Professor Per-Ingvar Bränemark and colleagues completed experimental work that was started in 1952. Their research led to the development and introduction of titanium root form implants.<sup>29</sup> His work revolutionized the approach to and acceptance of implants as a treatment modality. This type of endosseous implant (**figure 2D**) has become the most widely used implant in the world.

### **Endosseous Blade Implants**

The Endosteal Blade implant was introduced independently in 1967 by Leonard Linkow (**figure 9**) and also by Ralph and Harold Roberts (**figures 10A, 10B**).

### **Endosseous Ramus Frame Implants**

The Ramus Frame implant was developed in 1970<sup>16,30</sup> and was first fabricated from stainless steel. In 1982, the fabrication process was changed to titanium (**figures 11A, 11B, 11C, 11D**).<sup>31</sup>

## **EPOSTEAL DENTAL IMPLANT HISTORY**

### **Subperiosteal Implants (**figures 3A, 3B, 3C, 12**)**

One of the earliest designers of a subperiosteal implant was the Swedish practitioner Gustav Dahl who placed his first subperiosteal implant in 1940<sup>16,28,30</sup> or 1941.<sup>10</sup>

Aaron Gershkoff and Norman Goldberg of Providence, Rhode Island, were leading American pioneers in subperiosteal implant designs and techniques. They brought the technique of Dahl to the United States and performed their first surgical placement in 1948.<sup>10,32</sup> Their work consisted of making a complete mandibular impression of the soft tissues covering the edentulous jaw. They estimated the thickness and character of the mucosa using radiographs and palpation. They then scraped a cast to remove the appropriate amount of stone to reflect the tissue thickness.<sup>28,33</sup> From the modified cast they fabricated a vitallium casting. The tissues were then reflected and the implant fitted on the bone and held in place with screws.

Another American, Nicholas Berman of Seattle, Washington, altered Goldberg and Gershkoff's early technique. Recognizing that the bone must be exposed to accurately determine its morphology, Berman fabricated a stone cast from a modeling plastic impression of the mandible after the soft tissue had been reflected. Two or three weeks after the initial impression, he again uncovered the bone and fitted the meshwork under the periosteum and over the bone.<sup>33</sup>

In 1980 Philip Truit, a graduate student in Implant Dentistry at Loma Linda University School of Dentistry, completed research on the use of computerized tomography to produce a morphologic replication of the mandible.<sup>34,35</sup> His work consisted of comparing actual measurements with CT measurements on dry skulls and subsequently on cadavers. Adequate accuracy was not obtained on the first attempt and certain regions of the jaw were not accurately recorded when 18 separate anatomic landmarks were evaluated.<sup>34</sup> Subsequent research and improvements produced frameworks that fit with gaps that were generally less than 0.5 millimeter. The results showed sufficient accuracy to proceed with clinical patient treatment using this process. Over 200 subperiosteal implants were subsequently fabricated and placed at Loma Linda University School of Dentistry using the 3-dimensional modeling protocol which eliminated the need for a bone impression (**figures 13A, 13B, 13C**).

## TRANSOSTEAL DENTAL IMPLANT HISTORY

An early type of transosteal implant was developed in 1938.<sup>36</sup> A two-piece metal rod (that could be screwed together) was placed horizontally through the maxillary alveolar process to help retain a complete denture.

### The Mandibular Staple Bone Plate

In 1975 Irwin Small published a paper<sup>14</sup> describing the mandibular staple bone plate. This implant consists of a metal plate placed on the inferior surface of the anterior mandible with multiple metal posts that project into the mandible to provide bone anchorage and additional posts that project through the mandible and are used to provide support and retention for an overdenture or a complete arch fixed prosthesis (**figure 4B**).

### The Transmandibular Implant

Hans Bosker, in a thesis published in 1986, presented the results of experiments related to a gold alloy transmandibular implant. The experimental implants were first tried in 1975-1976. Five implants were subjected to technical testing and an additional 5 were placed in patients.

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